



Cisco research indicates that the total volume of worldwide IP traffic is doubling every two years.

By 2011, the world's IP networks will transport 29 exabytes of traffic . equivalent to 144 times the total amount of printed matter that exists today. ò ò .. each month!

WELCOME TO THE ZETA BYTE ERA!





The ZetaByte Era and The (R)evolution of the Transport Network



Vernon Thaver (vethaver@cisco.com)

Public Sector: Digital Cities, NReN

SP NGN (Core/Edge, Access/Aggregation and Optical)



Routing and Switching #15661

Agenda

- Evolution of transport networks
- Explosion in internet traffic
- Basics of a DWDM system
- Revolution of transport networks with IPoDWDM (An introduction)
- IPoDWDM benefits and Case studies
- Future Developments



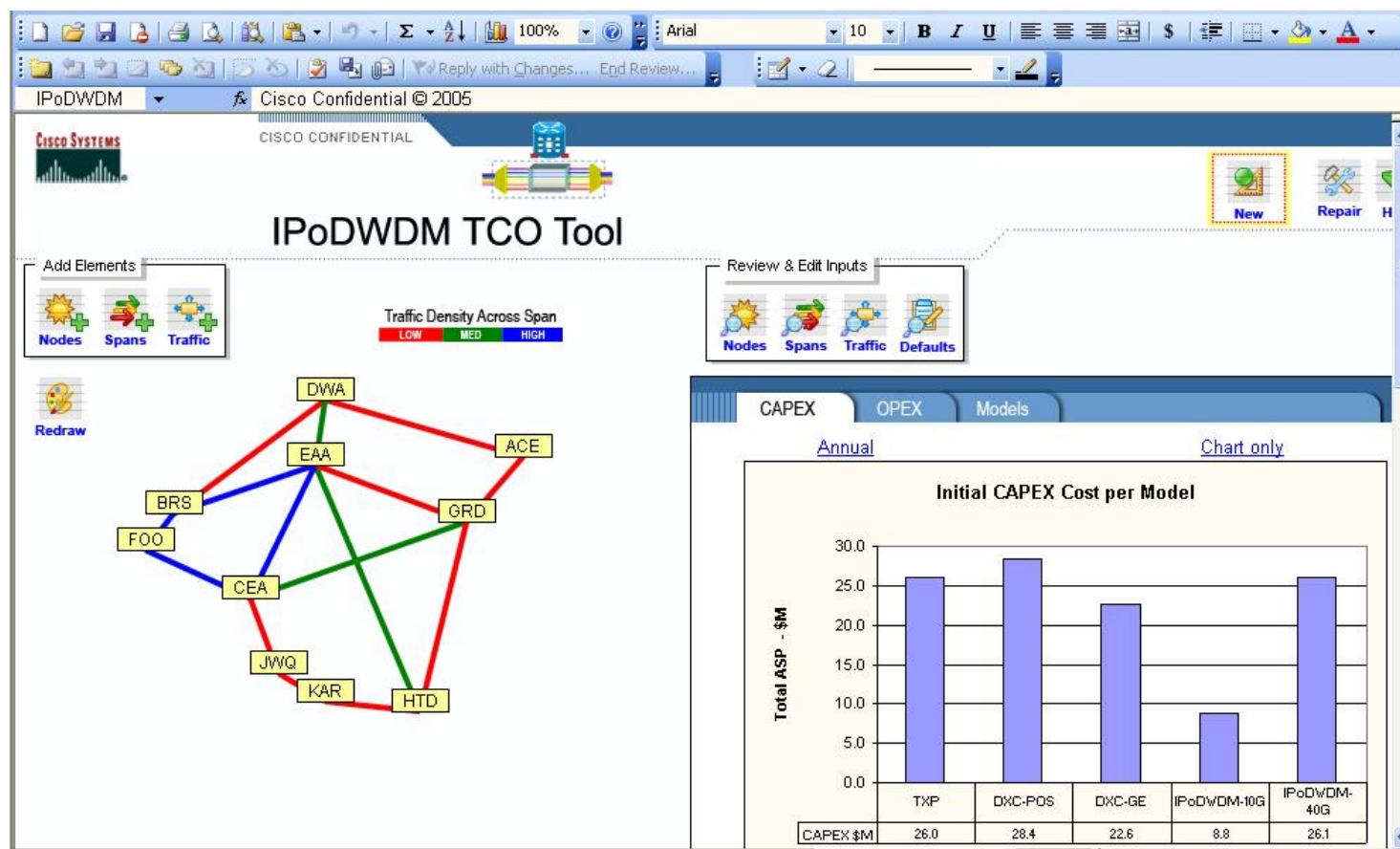


IPoDWDM Benefits and Economics Proof Points

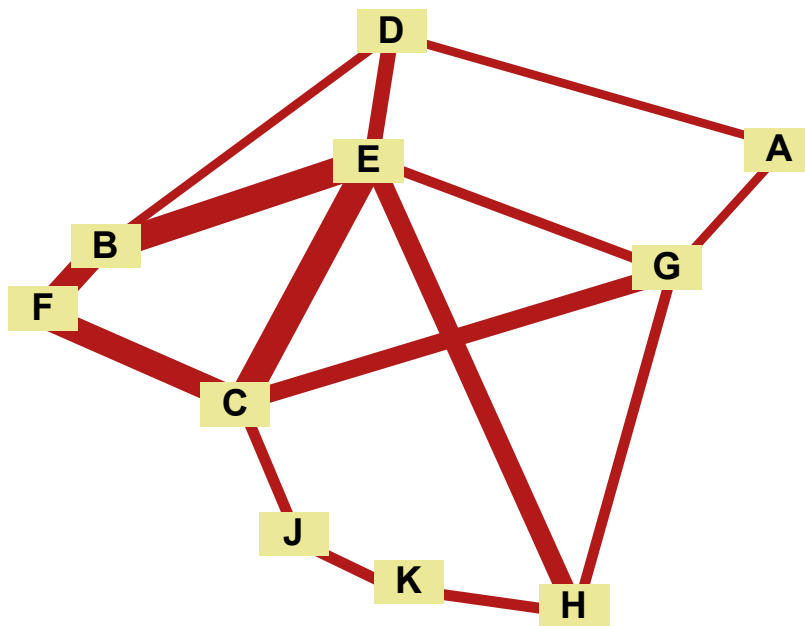


IPoDWDM TCO Modelling Tool

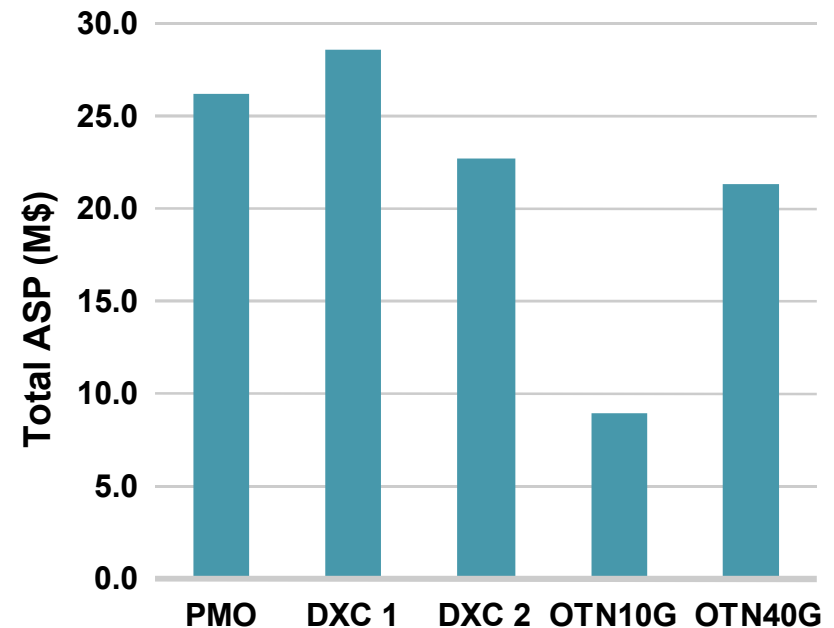
Excel based tool computes CapEx/OpEx based on customer data and price assumptions



CapEx Savings: Modeling the Savings on a Real SP Core Network



**Network Designs Based
on a Real SP Core Network**

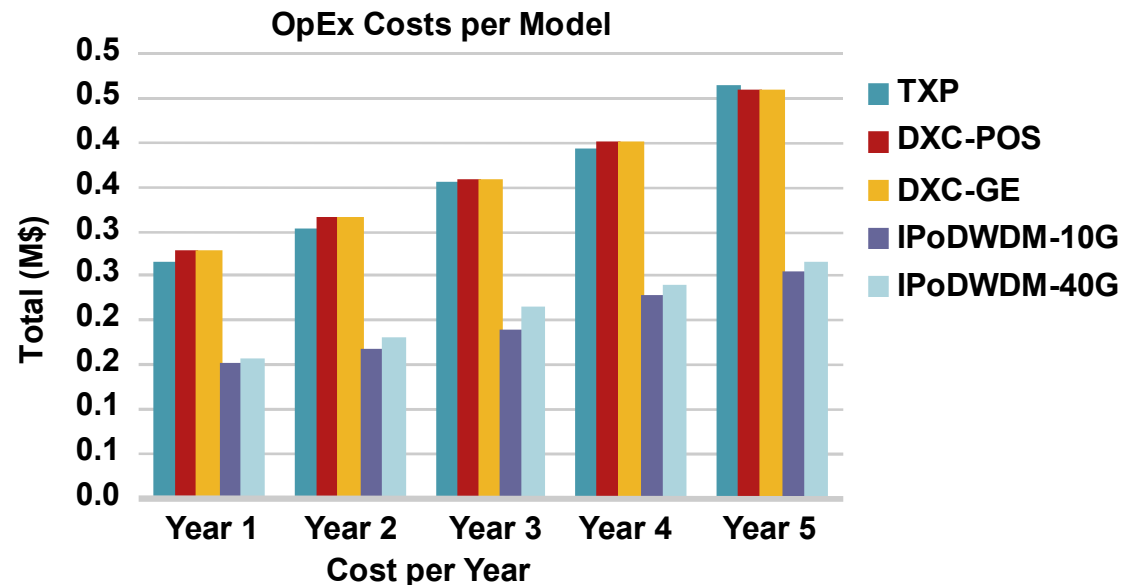


**Not Included: Components that
Are Common to All Architectures**

**IPoDWDM Reduces CapEx over Both Existing
Architectures and Future DXC-Based Architectures**

OpEx Savings on the Same Network

Significant OpEx Savings with IPoDWDM:



- XCs require truck roll to install short-reach optics for new λ
- ROADM is fully preprovisioned; no truck roll for new λ
- Eliminates manual patching
- Reduced EFI, maintenance, power, space, cooling

Source: Cisco Estimates

Benefits of an IPoDWDM Architecture

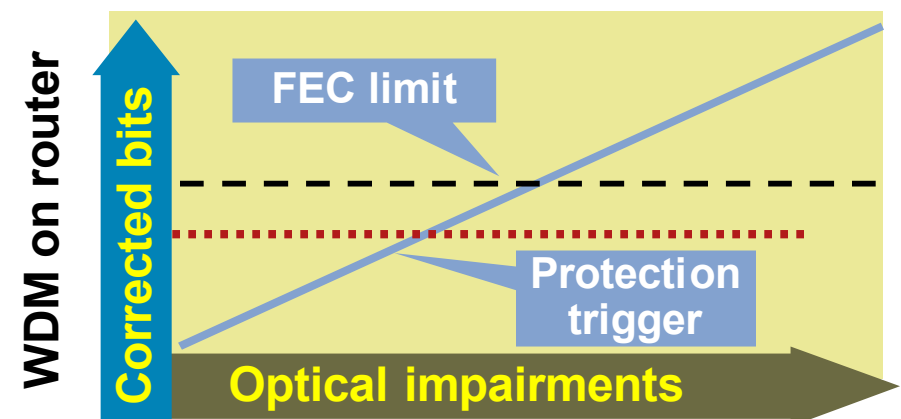
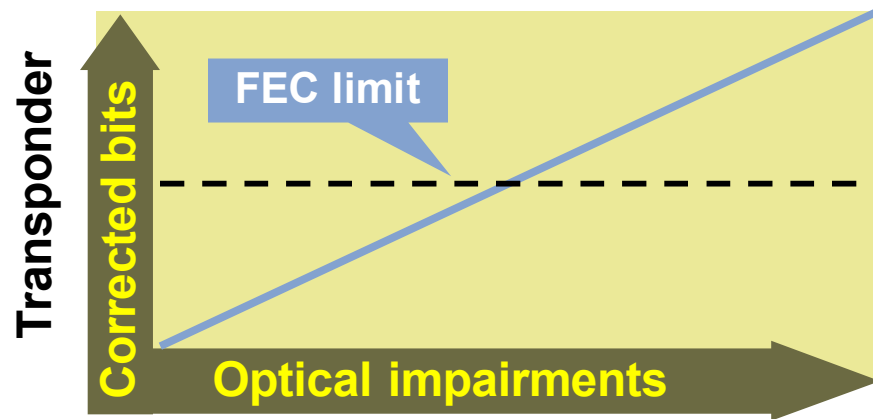
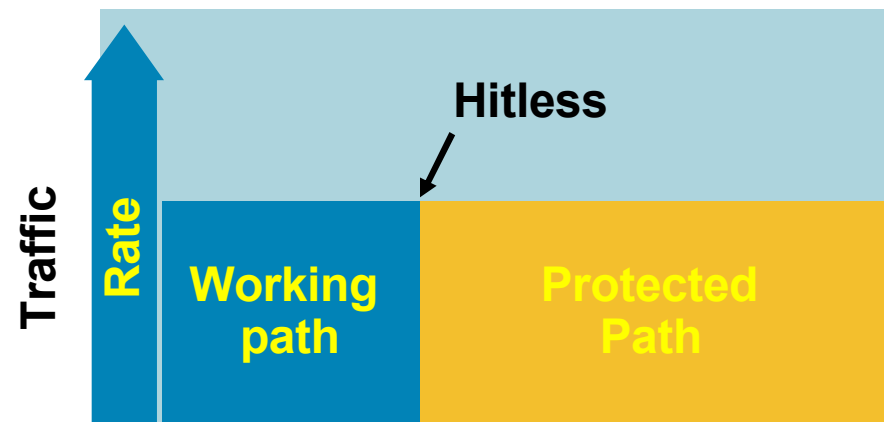
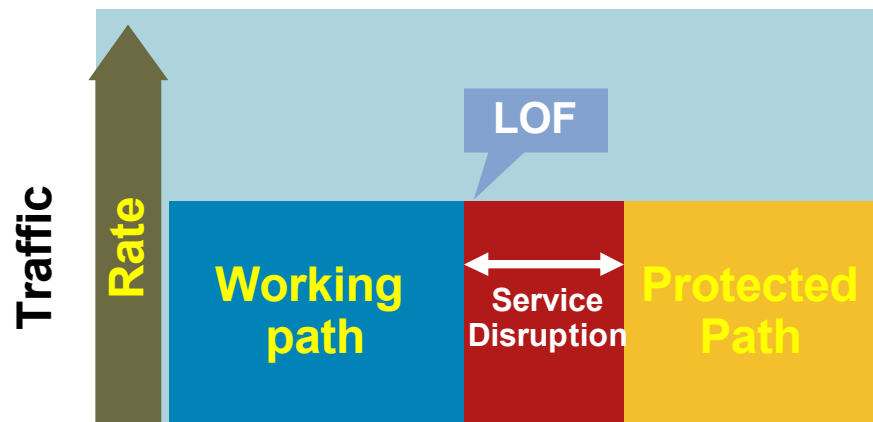
- **CAPEX Saving:** removing transponders, short reach optics and expensive OEO layer.
- **LABOR Saving:** Remove the need for manual provisioning and manual touches saves on truck rolls
- **Footprint Savings :** Transponders and active optics require
- **Reduced Power and Cooling:** Transponder consume significant power and eliminating transponder shelves saves power

Benefits of an IPoDWDM Architecture

- **SDH/SONET OAM/P:** G.709 provides for PM and OAM
- **Streamlined Operations:** Eliminating the segmented model approach to operations eg transport and IP (separate NMS) and replace with a single integrated management and control system.
- **Proactive Protection:** Refer to next slide and video

Element Integration Benefits

Hitless Switchover from Degrading Path



Element Integration Allows Router Visibility Into Transmission Layer Performance Enabling for Superior Protection Compared to Transponder-Based Networks

Protection Switching: Proof Of Concept

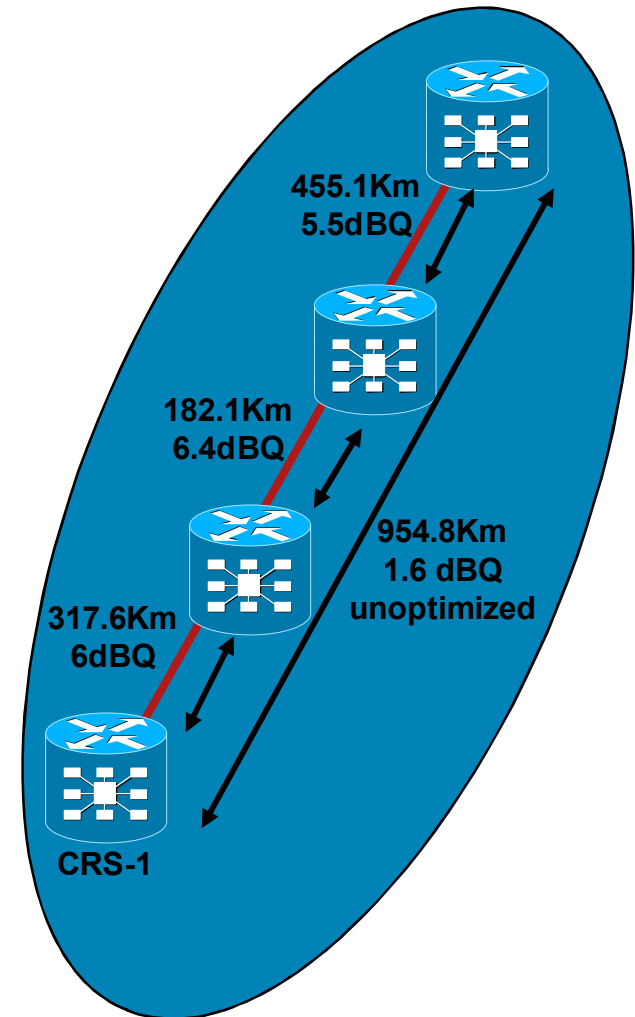
Cisco IP over DWDM
Enabling Layer 3 Proactive
Protection



Case Studies



First and Longest IPoDWDM Deployed Customer Application



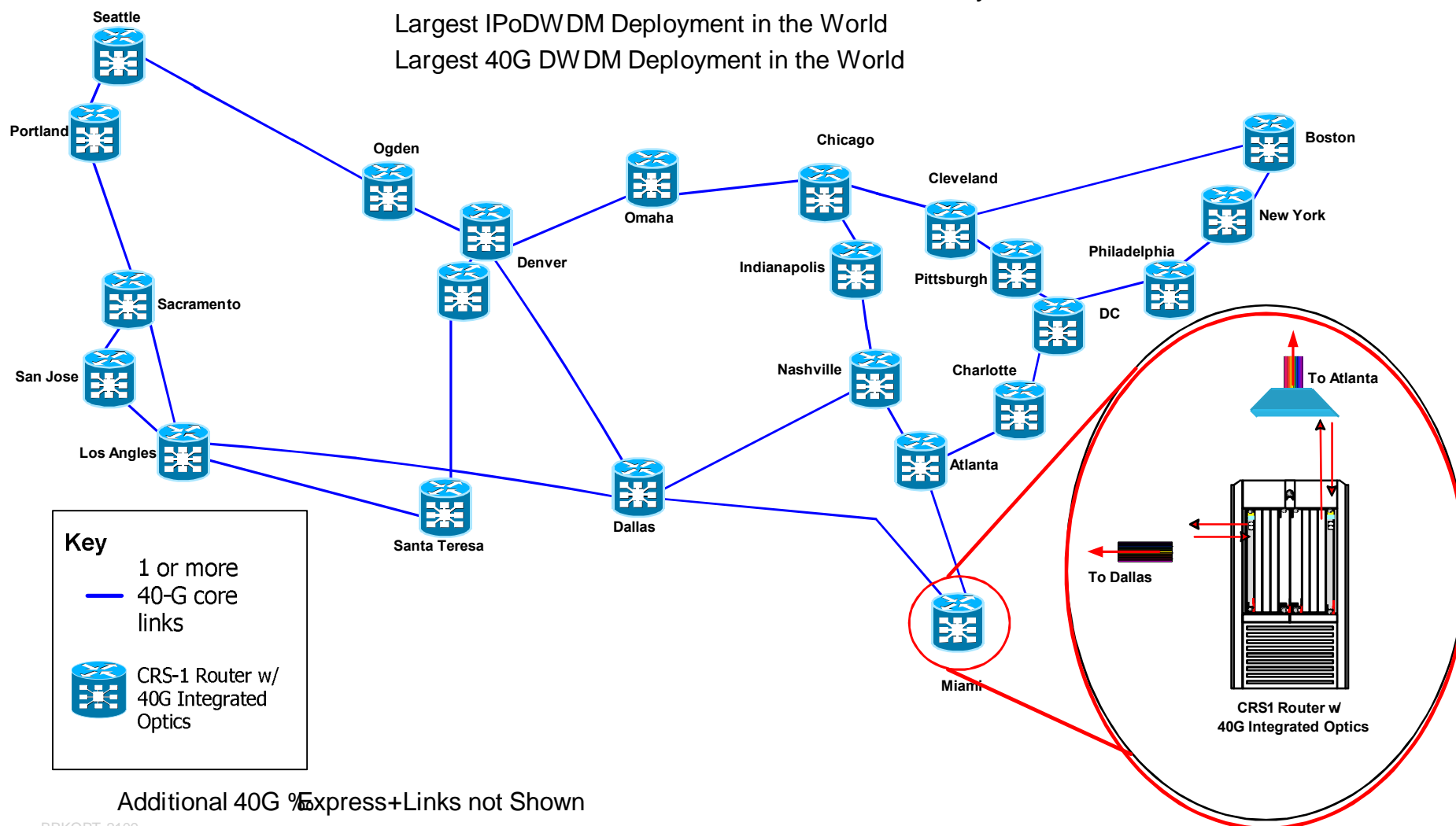
CRS-1 w/ Integrated 40Gig DWDM Optics

Network Architecture

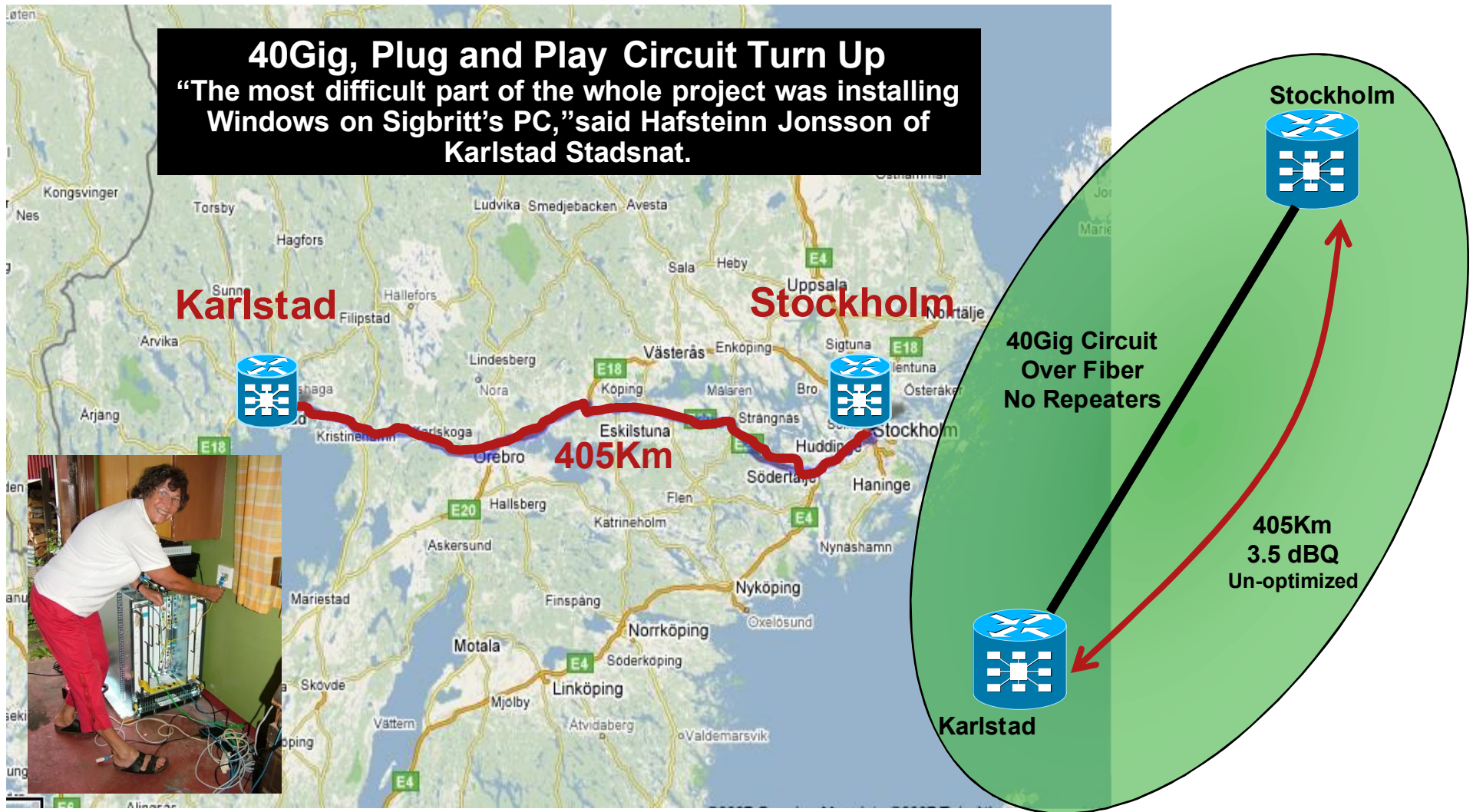
First 40G IPoDW DM Network in the World



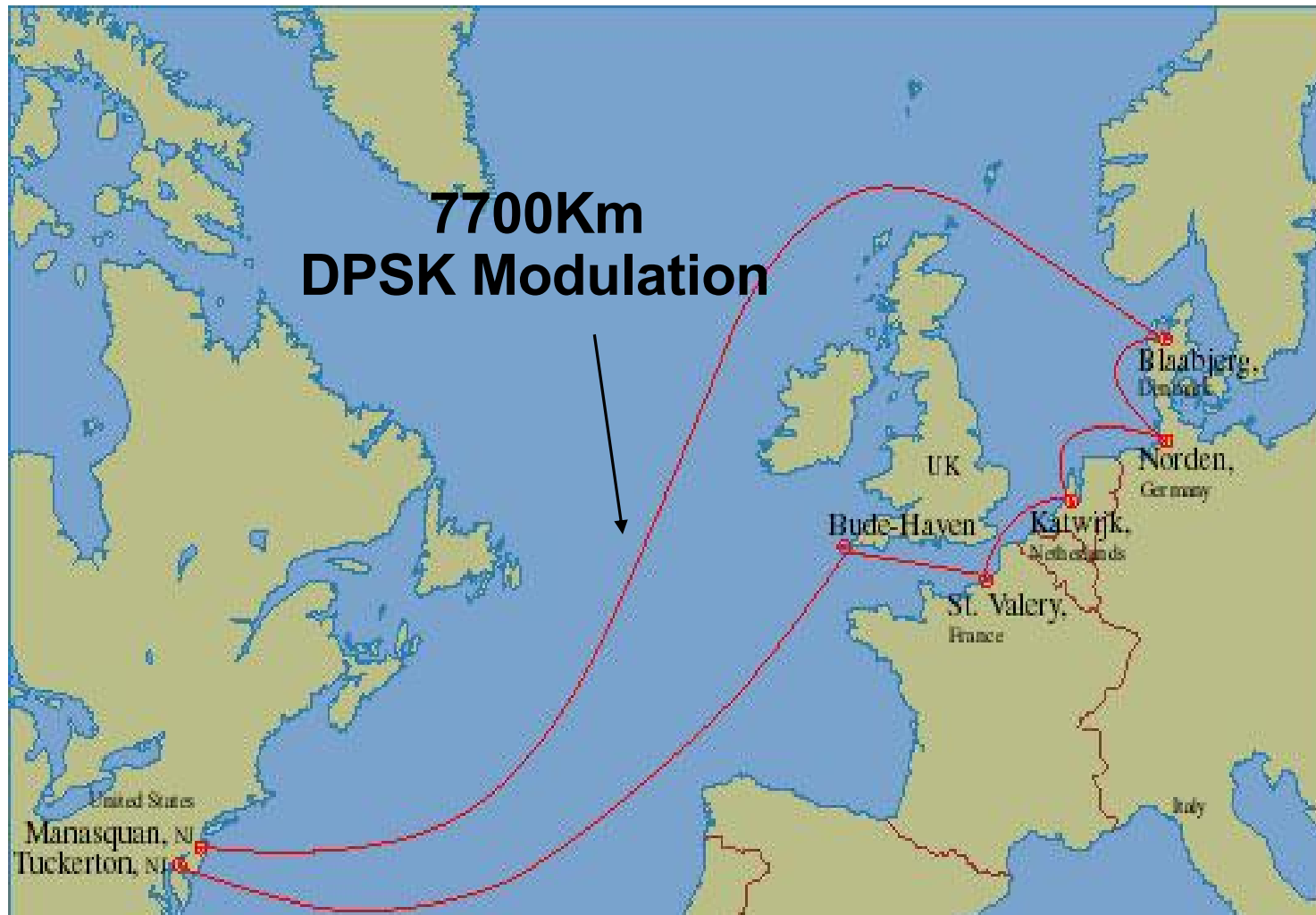
- This North American National Network is Currently:
Largest IPoDWDM Deployment in the World
Largest 40G DWDM Deployment in the World



World's First and Fastest Internet Connection to the home, 40Gig!

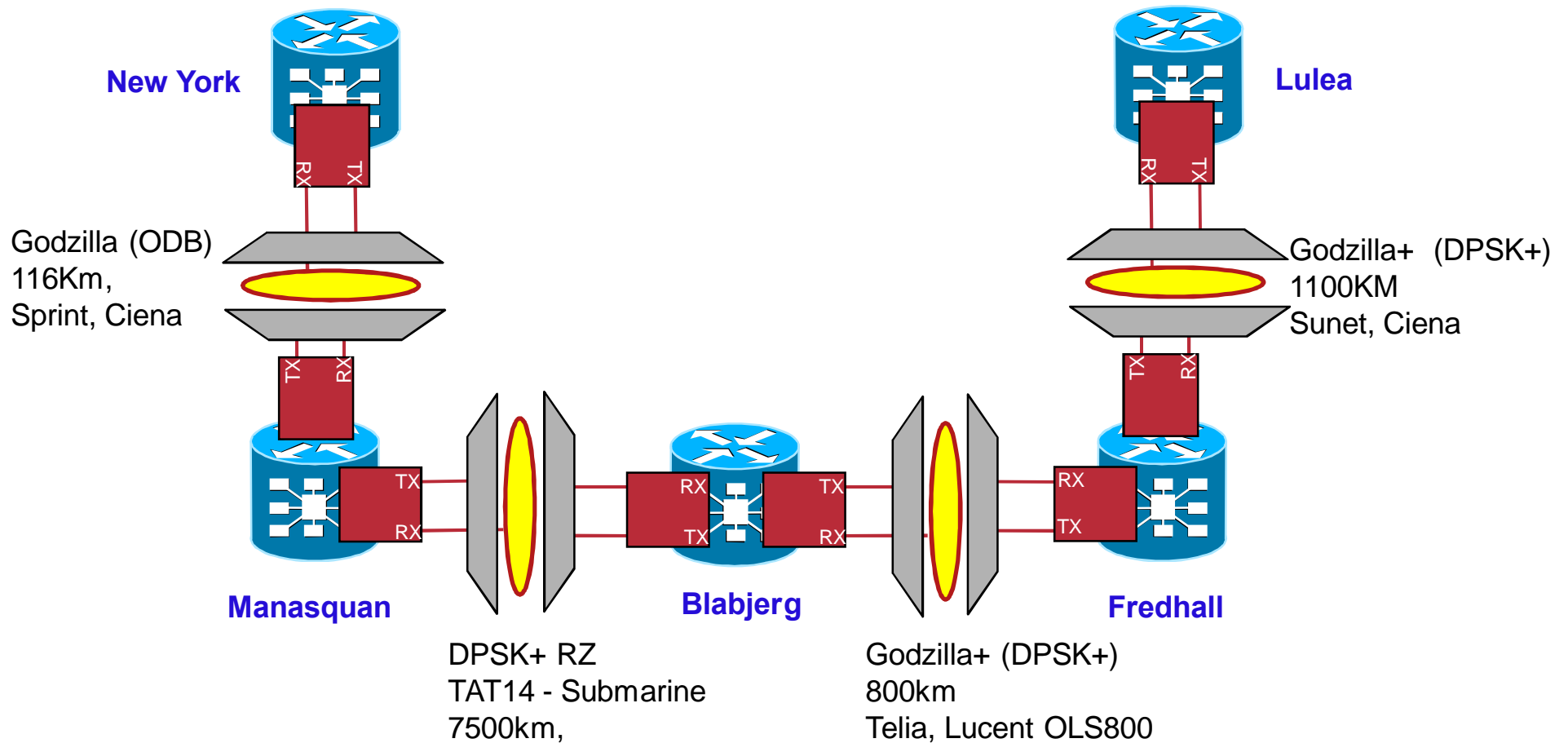


TAT-14 Cable Route



40Gb/s Transatlantic IPoDWDM

NY-LLA 40G Transatlantic Test, approx 9000Km



<http://biz.yahoo.com/bw/081121/20081121005708.html?.v=1>

TAT-14 Cable Route



Kathy Walker, chief information and network officer for Sprint, said:
"It serves as a reminder of how far technology has advanced.
TAT-14 and Sprint were the first to transmit data at 10-Gbps (OC192) speeds
across the same path in 2001.

Sprint and TAT-14 are making **history again**.
By transmitting **40Gbps over an existing 10Gbps DWDM system**,
we've demonstrated that Sprint can increase capacity for its customers while
minimizing additional capital and operational costs."

http://networking.cbronline.com/news/sprint_completes_trail_of_40gbps_transatlantic_ip_link_261108

SEACOM is building and will own & operate a high capacity undersea cable linking Africa to Europe and Asia via the Middle East

Overview

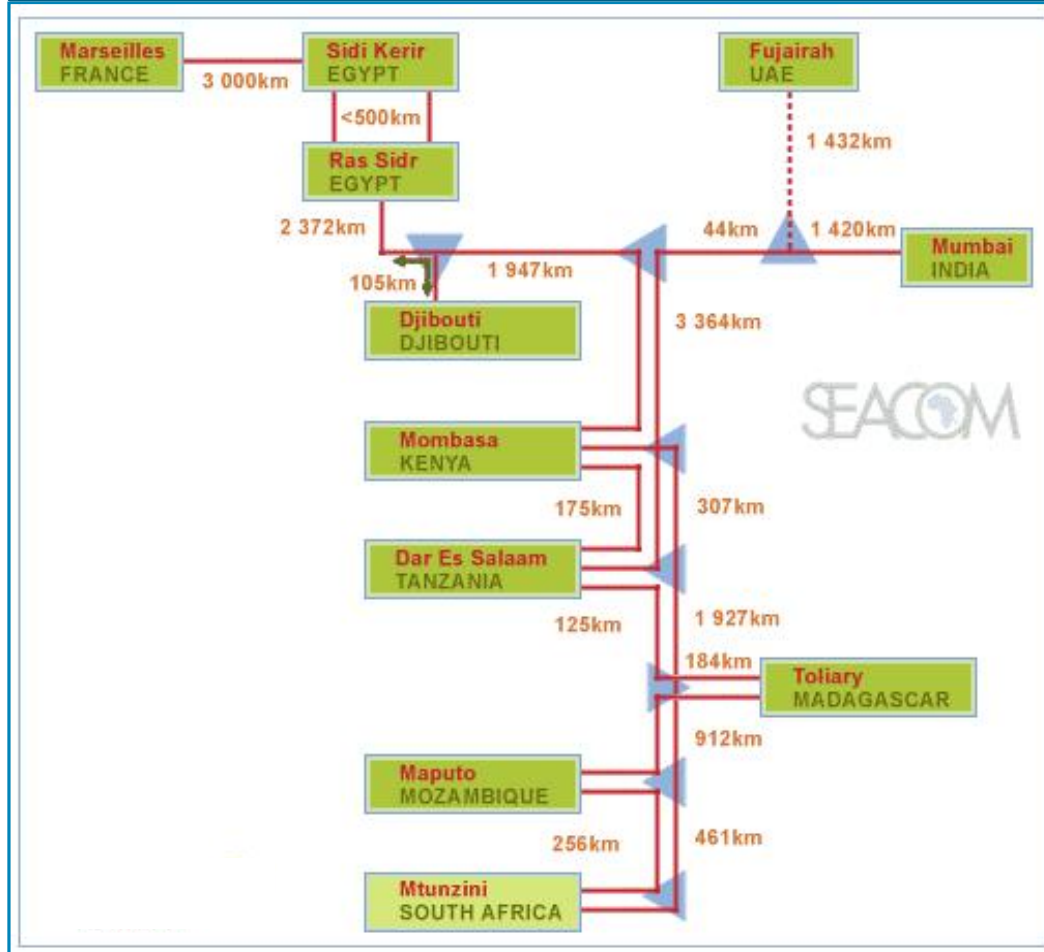
- State of the art, privately funded, submarine fiber optic cable that we will own and operate
- Enormous capacity of 1.28 Tb/s will enable Africans to enjoy high demand services such as HDTV, IPTV, true broadband Internet and peer-to-peer networks
- +/- 17 000 km route will link South Africa to Mumbai in India and Marseille in France via Mozambique, Madagascar, Kenya, Tanzania and Ethiopia (undersea portion > 13,500 kms)
- Internet and IP solutions as well as global onward connectivity for voice and private line solutions

SEACOM Topography



SEACOM's co-build with Telecom Egypt and VSNL enables onward to connectivity to Europe

Network Schematic



Design Information

“ The system is a single cable with individually owned fibre pairs within the cable.

TENET Signs Deal with SeaCOM

TENET

Tertiary Education Network

Tenet signs deal with Seacom

15 November 2007

Tenet has signed an indefeasible capacity purchase agreement with Seacom, which has started construction on an undersea cable that will land in KwaZulu-Natal.

Tenet runs a national research and education network on behalf of **40 research and educational institutions in SA** and surrounding areas. It is responsible for securing connectivity and associated services for the institutions it serves, and which control it. These institutions include all 23 of SA's universities and most of the research councils.

The deal with Seacom, says Tenet CEO Duncan Martin, %provides for us to acquire the use of **10Gbps wavelength** from Seacom's Mtunzini landing station, in KwaZulu-Natal (the same beach on which the SAFE cable comes ashore, but not the same facility), to London. The agreement gives Tenet the right of use for the life of the cable (expected to be 20 years) and allows Tenet to make the bandwidth available to education and research institutions in SA and in neighbouring countries on a cost-recovery basis.+

www.tenet.ac.za/site-work-space/anything/Briefing%20for%20Minister%20Erwin.doc

<http://www.hellkom.co.za/news/local/4961-Tenet-signs-deal-with-Seacom.htm>

IPoDWDM Momentum

Increasing Customer Success



Embratel, Brazil



Comcast Cable, USA



TeliaSonera, Sweden



CENIC, USA



Kazakh Telekom, Kazakhstan



Qatar Foundation, Qatar



CAT Telecom, Thailand



Ogero, Lebanon



Kuwait Information Network, Kuwait



Sprint, USA



China Netcom, China



eThekweni, South Africa



Cox, USA



Tertiary Education Network
TENET, South Africa

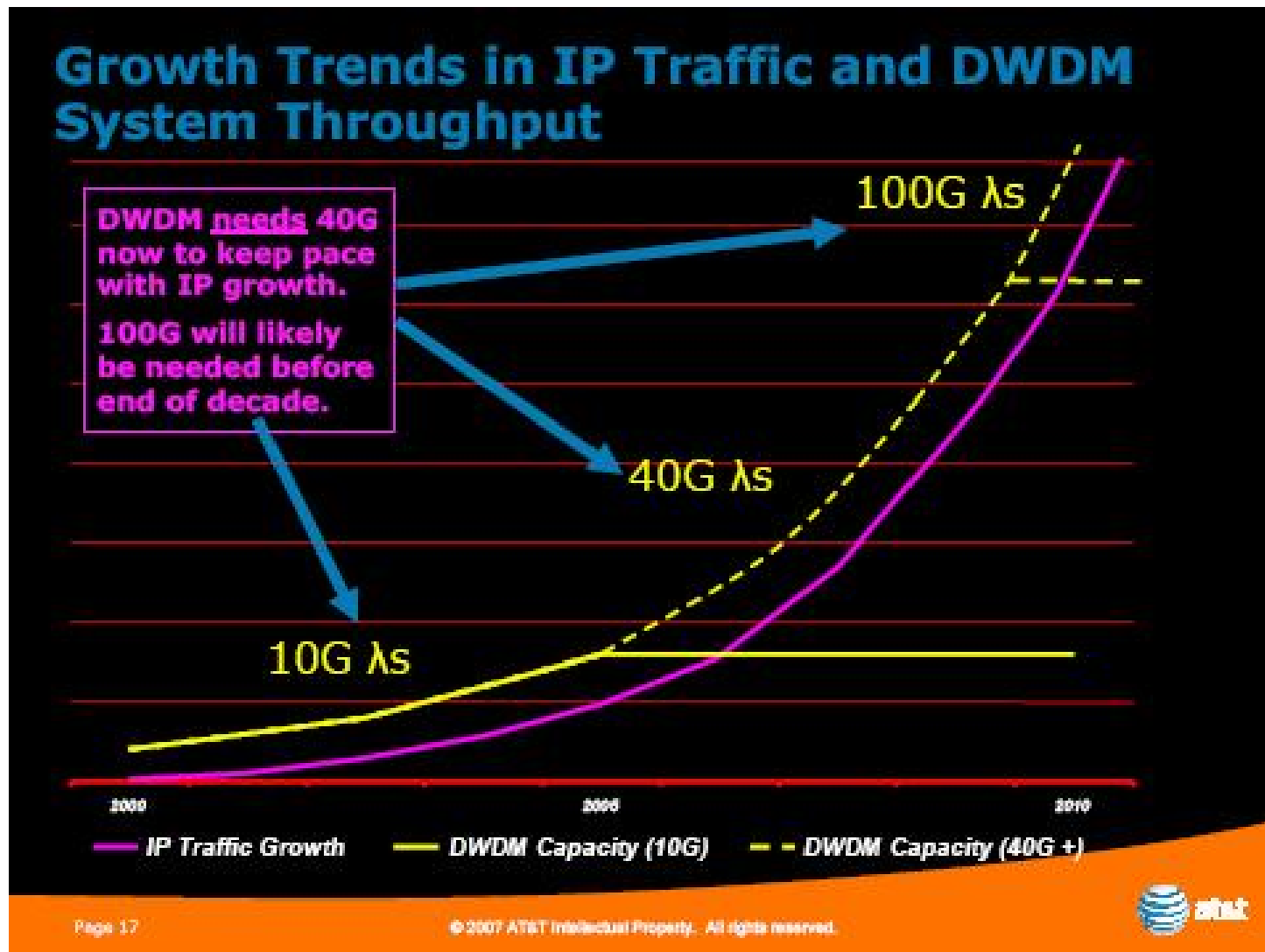


Future Plans/Developments



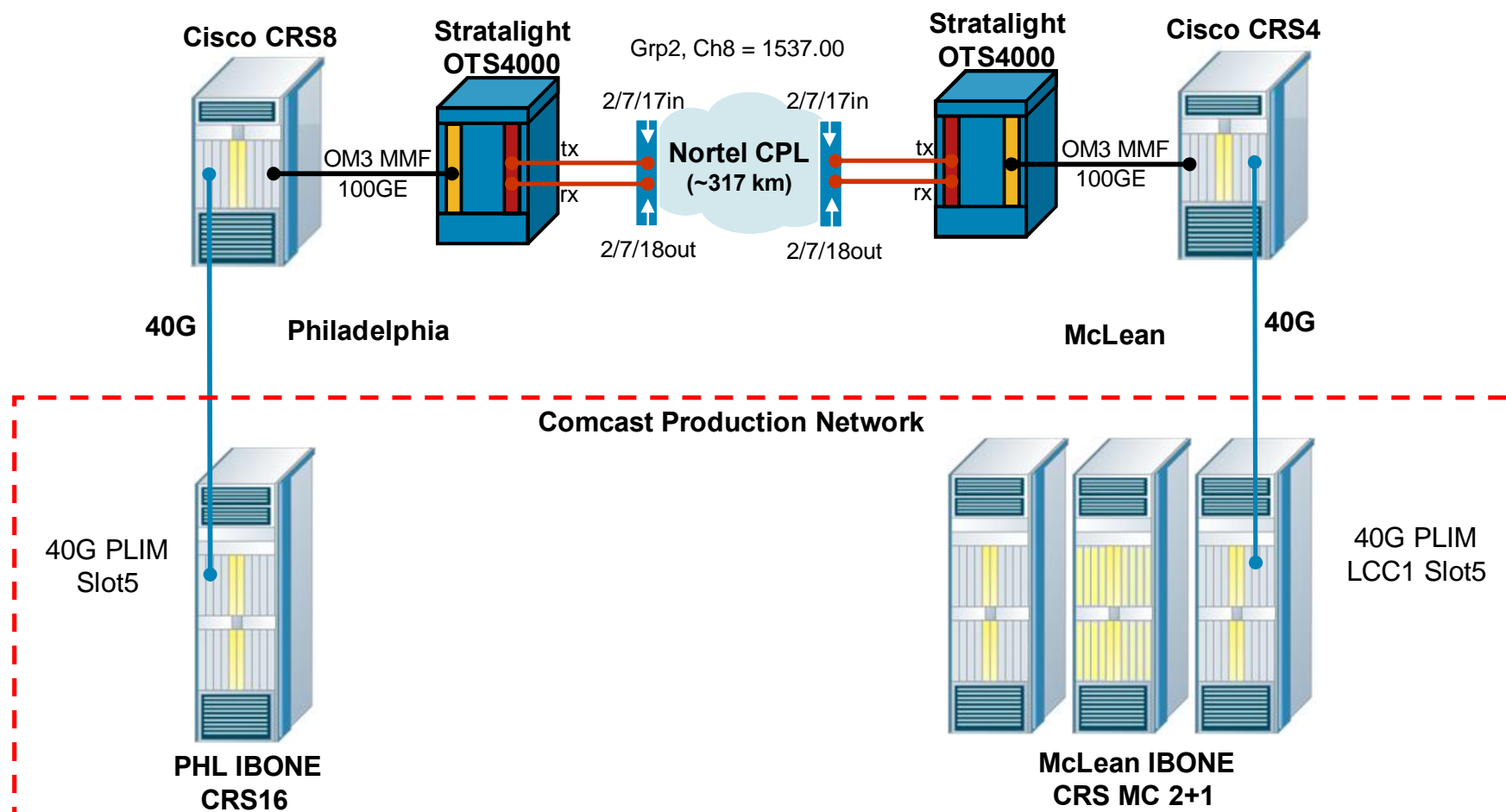
Rethinking Core Transport

Traffic growth should not limit transmission networks



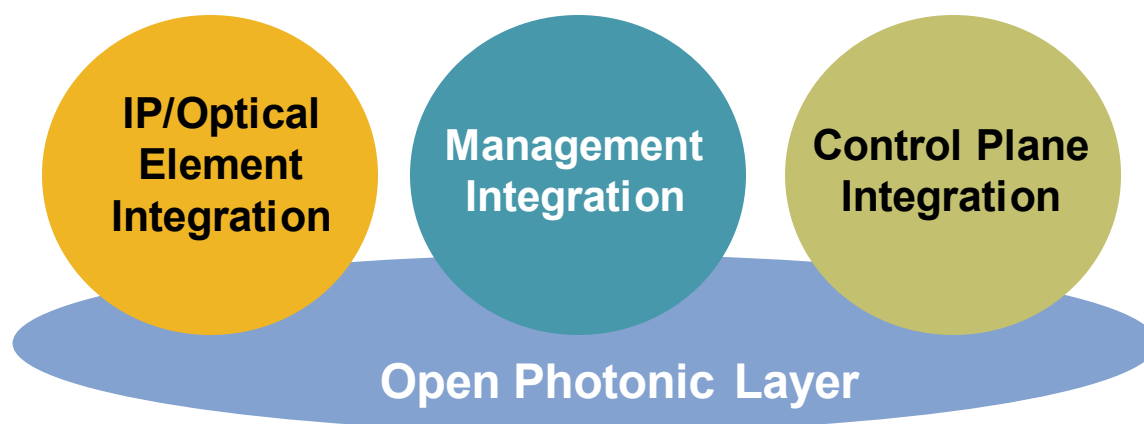
Cisco 100GbE demo – June08

100GE DEMO Network



IPoDWDM

Building Blocks and Technologies



- 10G DWDM interface on routers/switches as an entry point into the optical domain
- 40G DWDM interface over 10gbps optimized transmission
- 2.5G WDM SFP/GBIC for lower end applications
- Advanced DWDM layer w/ extensive optical control loops and monitoring

- Ring optical switching using ROADMs
- Mesh optical switching using routers/WXC
- Control plan technologies:
 - LMP
 - Peer model (GMPLS)
 - Overlay model (O-UNI)
- Network management integration

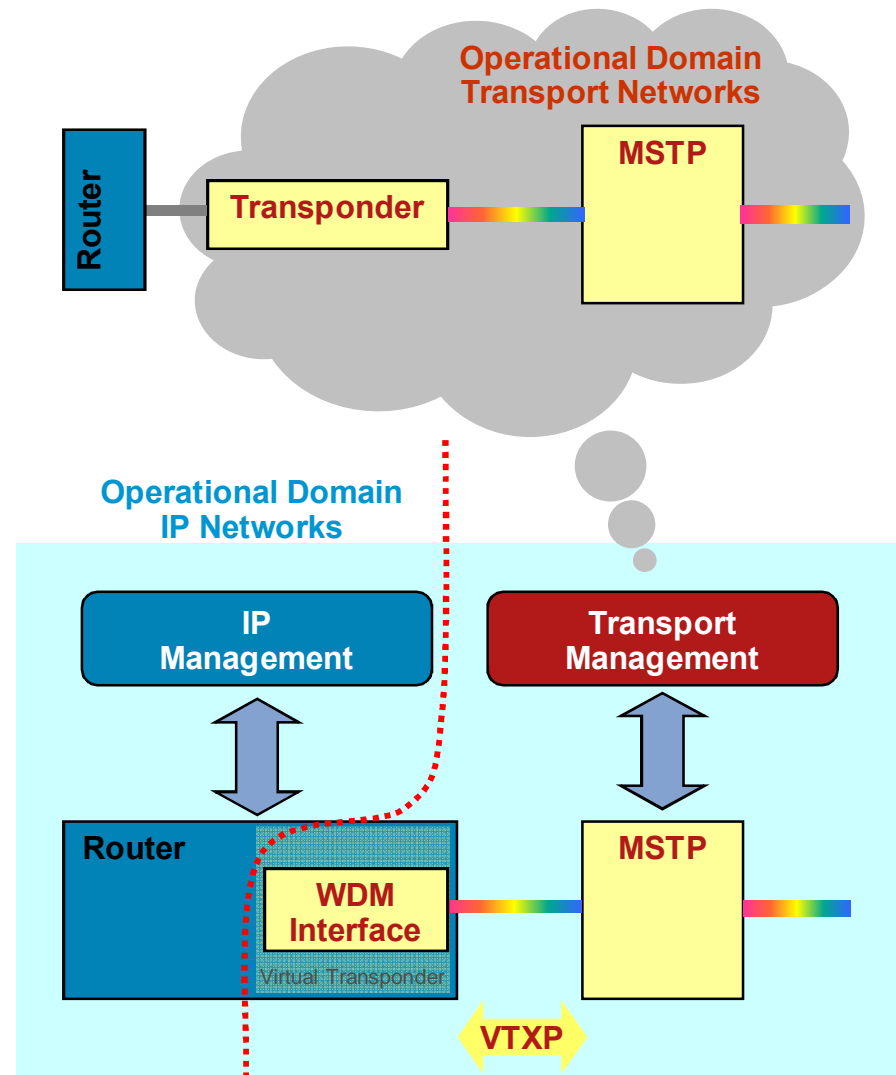
IPoWDM Innovations

Virtual Transponder Management

- **Pioneering** feature: Virtual Transponder Protocol (VTXP)
- **Open standards** (XML) based interoperating with 3rd party MSTP
- Full FCAPS Management for Router WDM interfaces

Flexible Management

- Segmented: No change to existing NMS/OSS, operational models
- Integrated Management



GMPLS Unified Control Plane Value Proposition

Reduce OpEx

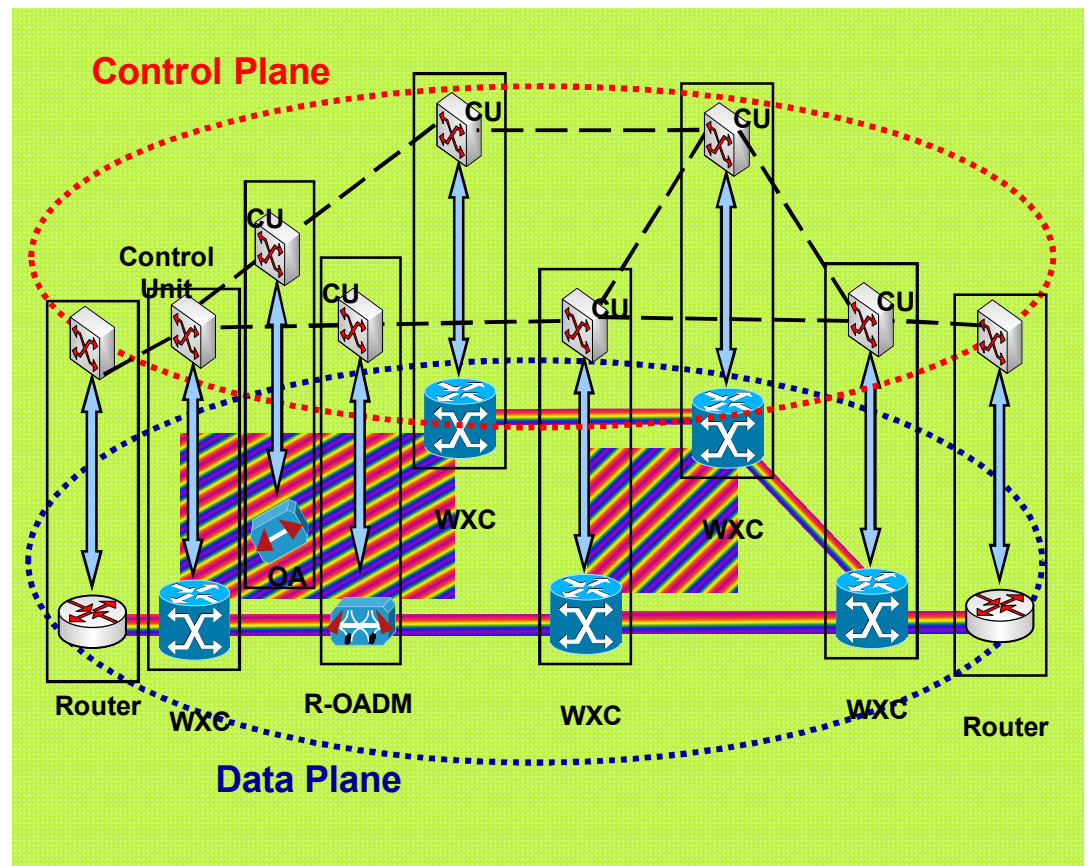
- Automated processes
- Automatic connection setup and release (simplified provisioning)
- Topology auto-discovery
- Rapid circuit provisioning
- Multi-vendor/domain layer integration

Reduce CapEx

- Improved network utilization
- Meshed restoration
- Resilience against multiple failures
- Resource management
- Traffic Engineering

Service Optimization

- Flexible / fast service provisioning
- Bandwidth on demand
- Class of Services at transport layer



Key Enablers for an Optical Control Plane managed DWDM network

- **Tunable Network** . An optical network where optical channels can be moved and changed to different wavelengths completely via software.
- **Colorless** . Applies to lasers, multiplexers, demultiplexers, and receivers. It is the ability to change the wavelength aspects of these devices without moving any physical fibers.
- **Omni-directional** . The ability to have a fixed fiber port interface directed to any of the degrees within the ROADM node.



